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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B29C 59/02	A1	(11) International Publication Number: WO 98/14317 (43) International Publication Date: 9 April 1998 (09.04.98)

(21) International Application Number: PCT/IB97/01179

(22) International Filing Date: 29 September 1997 (29.09.97)

(30) Priority Data:
9620412.8 1 October 1996 (01.10.96) GB

(81) Designated States: AU, JP, MX, UA, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

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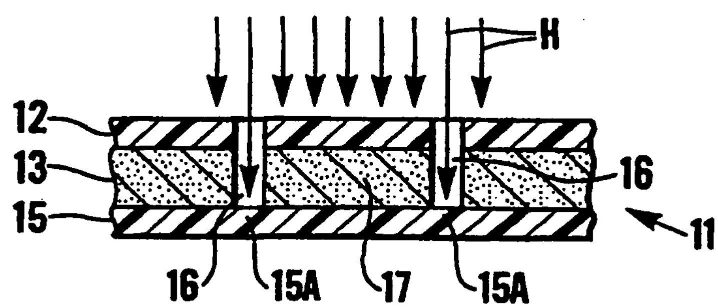
(54) Title: METHOD OF AND APPARATUS FOR TREATING A LAMINATE

(57) Abstract

A groove (16) is provided through a covering (12, 13) forming part of a laminate (11) and extending over a polymer layer (15) of the laminate (11). By way of the groove (16), a limited zone (15A) of the polymer layer (15) substantially aligned with the groove (16) is heated to a temperature such that, following cooling of the zone (15A), the zone is more readily breakable. The covering (12, 13) mitigates the effect of the heat H on other zones of the polymer layer (15).



METHOD OF AND APPARATUS FOR TREATING A LAMINATE

This invention relates to a method of and apparatus for treating a limited zone of a polymer layer of a laminate.

US-A-4265616 stated that it was known that orientation of an oriented thermoplastic polymeric film may be destroyed by heating the film to a temperature above the temperature at which the film was oriented. It disclosed a continuous process for forming a longitudinal heat-weakened strip in a cross-lapped oriented polyolefin film. The process comprises directing heat from two longitudinally aligned sources to opposing sides of a travelling web of the cross-lapped oriented polyolefin film, to such an extent that the tensile breaking strength at the heat-weakened strip so formed is in the range of 20 to 100 N. per cm. length of film. The film so formed is for packaging slurry explosives.

Containers are well known which comprise a laminate consisting of a substrate having one or more polymer layers to the inside thereof. It is known for the laminate to consist of the following layers progressing from the outside to the inside of the container: an outside polymer layer (for example LDPE-low density polyethylene), a substrate (for example paperboard), a barrier polymer layer (for example EVOH - ethylene vinyl alcohol) and an inside polymer layer (for example LDPE) contacting the contents, for example a fruit juice or long-life milk. It is particularly advantageous to keep the barrier polymer layer intact from the time of manufacture of the laminate to opening of the container by the customer. It is also known for the container to be so designed that opening of the container requires breaking of the barrier polymer layer by the customer, for example by the customer cutting through the barrier layer or pushing inwards a portion of the barrier layer. In order to facilitate opening of a pouring hole (in the event that, for example, the container has sealed to the exterior thereof a pouring spout closed by a cap), or of a drinking straw hole, the potential hole may be outlined by a closed- or open-loop groove formed through at least part of the outside polymer layer and the substrate so as to bound a portion of the laminate to be pushed inwards. The groove may be formed by

laser etching, die cutting, or milling, for example. It is also known to provide a similar arrangement for facilitating tearing-off of a portion of the container to open the same. In some circumstances, in spite of formation of the groove, the barrier polymer layer and the inside polymer layer may provide a greater resistance to breaking than desired for opening of the container by the customer.

US-A-5000321 discloses a package for holding commodities and fabricated from a multilayer compound foil material. The package includes at least one transversely extending closure seam and an opening arrangement positioned adjacent the closure seam. The opening arrangement includes an opening section which comprises line-shaped weakened sections in which the material of the compound foil is weakened as regards its breaking strength. These weakened sections may be grooves, so that synthetic layers which are lying on an aluminium layer are thinner than anywhere else on the pack compound foil. This can be achieved for example by heating it up with a laser beam. A change in breaking strength of a line-shape section can not only be achieved by macroscopic changes (groove), but also by way of changes in the inner material structure, for example by means of changes in the grade of polymerisation of the material.

According to one aspect of the present invention, there is provided a method comprising providing a laminate comprised of a polymer layer and a covering extending over a surface of said polymer layer, with the external surface of the covering being provided with a hole therethrough, characterized by transmitting energy by way of said hole to a limited zone of said polymer layer substantially aligned with said hole to heat said limited zone to a temperature such that, following cooling of the limited zone, said limited zone is more readily breakable.

According to another aspect of the present invention, there is provided apparatus comprising supplying means for providing a laminate comprised of a polymer layer and a covering extending over a surface of said polymer layer, with the external surface of the covering being provided with a hole therethrough, characterized by energy-transmitting means

arranged to transmit energy by way of said hole to a limited zone of said polymer layer substantially aligned with said hole to heat said limited zone to a temperature such that, following cooling of said limited zone, said limited zone is more readily breakable.

Owing to the present invention, it is possible to limit relatively accurately that zone or those zones of the polymer layer the resistance to breakage of which is actually reduced, since the covering serves as a mask mitigating any effect, on other zones of the polymer layer, of the energy which produces heating of the limited zone(s). As a result, it is not necessary to use very accurate and expensive heating apparatus, for example laser apparatus, and less accurate and cheaper heating apparatus, for example hot air emitters, can be used.

The Applicants believe, although are by no means certain, that the reason why the heating in question weakens the polymer in such a way as to make it more breakable is that the relatively high molecular orientation which arises through processes, such as extrusion coating, for formation of the polymer layer provides relatively high resistance to breaking, but that the application of the heat to the layer reduces the degree of molecular orientation in the layer and so reduces the resistance to breaking. Therefore, it would seem that the heating should be such as to produce a significant reduction in the degree of molecular orientation in the polymer layer.

The present invention is particularly, but not exclusively, applicable to a packaging laminate, especially to such laminate which forms a packaging container where breaking of the limited zone of the polymer layer by the customer is required to open the container. Additionally or alternatively to the customer obtaining access to the contents through a pouring spout encircling the limited zone, he could obtain access via a drinking straw used to break through the limited zone, and/or by tearing off a portion of the container along the limited zone.

When the packaging laminate consists of a substrate with a barrier layer to the inside thereof, if the barrier layer

is a metal foil, for example aluminium foil, the polymer layer (e.g. of PE-polyethylene, co-polymers of PE, or ionomers) to be rendered more breakable would be to the inside of the metal foil, probably in contact with the contents of the package. In the event that the barrier layer is a polymer layer (e.g. of EVOH, PA-polyamide, PET-polyethylene terephthalate, or PEN-polyethylene naphthalate), then the barrier layer and any polymer layer(s) to the inside thereof are advantageously rendered more breakable.

The heating should be at least sufficient to soften the limited zone of the polymer layer throughout at least a major part of its thickness and preferably sufficient to melt that zone throughout at least a major part of its thickness.

The time of heating at the softening point or melting point of the polymer layer should be for between 0.1s. and 5s., preferably between 0.5s. and 2s.

The heating may be performed by hot air, radiantly, ultrasonically or inductively.

To achieve dedicated heat for a sufficient time, the heating is preferably performed in a machine in which a laminate web is converted into filled containers. Alternatively, in a system where blanks are cut from a laminate web and supplied to a forming, filling and sealing machine, the heating is preferably performed upon that machine. In the latter system, it might instead be possible to perform the heating in a plant in which the web is converted into the blanks.

The polymer layer to be rendered more breakable may have been provided by extrusion, co-extrusion, or lamination.

The hole may be various shapes as viewed perpendicularly to the laminate; for example, it may be a curved and/or linear groove and may be formed by laser etching, die cutting or milling, for example.

In order that the invention may be clearly understood and readily carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a block diagram representing a packaging machine in which a filled carton is produced directly from a web of packaging material,

Figure 2 is a fragmentary, developed view of a laminate wall of a tube formed from the web,

Figure 3 is a perspective view of a filled and sealed carton produced on the machine of Figure 1,

Figure 4 is a block diagram representing a converter of an alternative version of the system, in which the converter converts a web into flat carton sleeves,

Figure 5 is a plan view of a carton blank cut from the web in the converter of Figure 4,

Figure 6 is a fragmentary section taken on the line VI-VI of Figure 5,

Figure 7 is a diagrammatic perspective view of a filled and sealed carton produced employing the blank of Figure 5,

Figure 8 is a block diagram representing a packaging machine of a modified version of the latter system, in which machine filled and sealed rectangular cartons are formed from carton sleeves,

Figure 9 shows a diagrammatic vertical section through a filled and sealed gable top carton produced on the machine of Figure 8, and after opening by the consumer,

Figure 10 shows a section taken on the line X-X of Figure 9, but at the commencement of opening by the consumer, and

Figure 11 shows an alternative version of the detail shown in Figure 2.

Referring to Figure 1, a packaging machine 1 receives a web 11 which is printed with artwork by a printing device 2, and then a hole-forming device 3, for example a rotary milling head,makes in the web a hole in the form of a groove 16. Then the web 11 is formed into a vertical tube which is heat-and pressure-sealed along overlapped edges thereof, and portions 15A of a polymer layer 15 are heated at substantially the same time. The apparatus for forming and sealing the tube and for heating the portions 15A are indicated at 4. The tube advances downwards and, by means of a filling device 5, a liquid product therein to be packaged is continuously topped up to a substantially constant level in the tube. Then a sealing device 6 seals the downwardly advancing tube transversely at intervals therealong, trapping

liquid product between the seals, and the transverse seals are severed centrally of their widths by a severing device 7, to produce tetrahedral, filled and sealed cartons each substantially identical to the carton 8 shown in Figure 3. The laminate structure of the web 11 supplied to the packaging machine 1 may be of any suitable character, for example of the character shown in Figure 2, 6 or 9. Referring to Figure 2, the laminate web 11 consists of an outside polymer layer 12, a paperboard layer 13, and an inside polymer layer 15, which latter is to contact the liquid contents of the carton 8 ("outside" and "inside" are with respect to the positions of the layers in question in the carton 8 produced). Formed through the layers 12 and 13 to the outside surface of the layer 15 is the groove 16, which is of closed- or open-loop form and which bounds a portion 17 of the layers 12 and 13 which is to be pressed inwards by a consumer in order to rupture the layer 15 around the base of the groove 16 to allow the portion 17 to be pushed into the interior of the container to permit the contents to be sucked out through the straw-hole so formed. As indicated by the arrows H, heat in the form of hot air emitted at a temperature of about 600°C, but naturally arriving at the web 11 at a lower temperature, is applied to the web in the region of the portion 17 for about 1.3s. and some of the heat penetrates to the base of the groove 16 (1mm. width) throughout the extent of the groove. By thus exposing the limited zone 15A of the polymer layer 15 at the base of the groove 16 to intensive heat for a short period of time, an internal structural change in the layer 15 at that zone 15A occurs and remains after cooling.

Although the heating of the zone 15A has utility with a laminate of the character shown in Figure 2, it has greater utility with a laminate of the character shown in Figure 11, where a barrier layer 14, especially a layer constituting a good barrier to oxygen, is interposed between the paperboard layer 13 and the inside polymer layer 15, so that pushing-in of the portion 17 is more difficult. The barrier layer 14 may consist of a metal foil, for example aluminium foil, or be a polymer layer (e.g. of EVOH, PA, PET or PEN; it is

illustrated in Figure 11 as being a polymer layer. In the version of Figure 11, the heat supplied is preferably such that both the limited zone 14A of the layer 14 at the base of the groove 16 and the limited zone 15A undergo internal structural changes which remain after cooling.

In a test on a carton of gabled-topped character having an outside polymer layer 12 consisting of LDPE of 14 microns thickness, a paperboard layer 13 of 400 microns thickness, an aluminium layer 14 of 8 microns thickness having outside and inside tie layers of 15 microns and 6 microns thickness respectively, but not illustrated, and an inside polymer layer 15 consisting of LDPE of 50 microns thickness, the force required to be applied to the portion 17 to rupture the layers 14 and 15 was found to be approximately 80N. Following heating in the manner indicated, the corresponding force required was found to be approximately 40N.

In the converter 20 illustrated in Figure 4 and of the alternative version of the system, a laminate web 11 is printed with artwork by a printing device 21, and grooves 6' are formed in the web 11 by a hole-forming device 22, which is preferably one or more lasers. Then the advancing web 11 has blanks 23 each as shown in Figure 5 cut therefrom by a device 24. The blanks 23 are forwarded to a heating apparatus 25 where respective edges of the blanks 23 are heated to render them tacky. Then the blanks 23 are folded into flat, carton sleeves by a folding device 26, the tacky edges forming side seams of the sleeves. The sleeves are forwarded to a heating apparatus 19 where the limited zones 15A' are heated to the required temperature. Since the time period required for heating is relatively long, the speed of movement of the sleeves through the apparatus 19 is much less than the speed of movement of the web 11 and the blanks 23 through the converter 20.

Referring to Figure 5, each blank 23 is formed with a set of score lines 27 to provide a row of bottom closure sealing panels 28, a row of bottom closure obturating panels 29, a row of side wall panels 30, a row of top closure obturating panels 31, and a row of top closure sealing panels 32. The groove 16' is mainly linear extending along the

boundary between the row of top closure obturating panels 31 and the row of top closure sealing panels 32. However, the groove 16' has its end portions 16A' extending to the free edge 33 of the row of top closure sealing panels 32.

The laminate 11' of the blank 23 may be of any suitable character, for example the character shown in Figure 6, which corresponds to that shown in Figure 9, except that the barrier layer 14 is a metal foil, particularly aluminium foil. As indicated by the arrows H' in Figure 6, heat in the form of radiant heat emitted at a temperature of about 600°C, but naturally arriving at the blank 23 at a lower temperature, is applied to the blank in the region of the groove 16' for about 1.3s. and some of the heat penetrates to the base of the groove 16' (which is 1mm. in width) throughout the extent of the groove. By thus exposing the limited zone 15A' of the polymer layer 15 at the base of the groove 16' to intensive heat for a short period of time by conduction through the foil layer 14, an internal structural change in the layer 15 at that zone occurs and remains after cooling.

After the blank 23 has been folded into a flat, side-seamed sleeve, it is transported to a forming, filling and sealing machine, at which the flat sleeve is opened to a rectangular form, the sleeve is placed over a mandrel of a turret, a sealed bottom closure is formed while the sleeve is on the mandrel, the open-top carton so formed is stripped from the mandrel and forwarded to be filled and top-sealed to provide a flat-topped carton 34 of the character illustrated in Figure 7, where the ends of the fin seal provided by the top closure sealing panels 32 are tacked down onto respective side wall panels 30. To open the carton, the consumer simply untacks from the side wall 30 the end of the fin seal through which the groove 16' extends and turns it upwardly, and then, beginning at the inner end (16A') of the doubled groove 16', tears away that length of the sealing fin bounded by the groove, the polymer layer 15 and thus the aluminium foil layer 14 tearing along the limited zone 15A'.

In the system described with reference to Figures 4 to 7, the forming of the grooves 16' and the heating of the

zones 15A' is performed on the converter. In the modified version of which the packaging machine 35 is shown in Figure 8, such grooves are not formed, nor are such limited zones heated, on the converter, but instead the forming of the grooves (of whatever shape and size) and the heating of the limited zones is performed upon the packaging machine 35 instead. In that machine, the side-seamed sleeves are opened by an opening device 36. Then, as indicated at 37, the sleeves are placed over mandrels of a turret. While the sleeves are on the mandrels, sealed bottom closures are formed thereon, the grooves, for example the loop-form grooves 16, are formed, for example mechanically, in the outside surfaces of the sleeves, and the limited zones 15A are heated to the required temperature, all by apparatus indicated at 38. The cartons are then stripped from the mandrels, as indicated by 39, and forwarded to a filling device 40 and then to a device 41 which forms sealed top closures of the cartons, whereafter a pour spout fitment applicator 42 attaches pour spout fitments 43 to the cartons 51.

Referring to Figures 9 and 10, the gable-topped carton 51 has top closure roof panels 52 and 53 and a top closure sealing fin 54. The liquid contents 55, for example milk or orange juice, of the container 51 almost fill the container, leaving a head space 56 bounded by the roof panels 52 and 53. The container 51 consists of a laminate 11 comprised of the following layers at least, progressing outwards:-

an inner thermoplastics layer 15, for example low density polyethylene (LDPE), constituting a barrier to the liquid contents 55,

a layer 14, for example aluminium foil or ethylene vinyl alcohol (EVOH), constituting a barrier to gaseous substance, for example oxygen,

a stiffening layer 13, for example of paperboard, and an outer thermoplastics layer 12, for example LDPE, constituting a barrier to water.

In the panel 52, there is laser-cut through the outer thermoplastics layer and the stiffening layer, but not

through the gaseous substance barrier layer or the inner thermoplastics layer, and thus in the form of a partial-depth cut, a circular, but open, loop-form groove 16'', which thus extends over the outside surface of the panel 52. Heat-and pressure-sealed to the outer thermoplastics layer around the groove 16'' is an annular, outwardly directed flange 58 of a ring 59. The ring 59 includes an externally threaded intermediate annular part 60 and an inwardly directed, annular, upper flange 61. The ring 59 encircles co-axially a tubular spout 62 and is connected thereto by frangible, thin, bridging portions 63. The ring 59 and the spout 62 are injection-moulded in one piece from polyethylene. The lower edge 64 of the tubular spout 62 is formed as a knife-edge of a diameter almost as great as that of the groove 16''. It has a cylindrical, inner sealing surface 65 and an outer, convex, annular sealing surface 66. In the condition in which the container is received by a consumer, there is screwed onto the ring 59 a closure cap 67 having a radially outer skirt 68 which is internally threaded at 69 for co-operation with the part 60. The cap 67 also has a downwardly depending inner skirt 70, the radially outer surface of which is cylindrical for co-operating sealingly with the surface 65. The spout 62 is formed with an external, annular shoulder 75 for abutting against the flange 61. Having received the carton 51, and to open the pouring fitment 43, the consumer firstly unscrews and removes the cap 67. Then the consumer uses his finger or thumb to push the spout 62 inwards to break the bridging portions 63. One result of the inward movement of the spout 62 is that the surface 66 slides sealingly within the surface 63 and rides through the surface 63 to snap into a fixed position shown in Figure 9, in which the shoulder 75 abuts the flange 61. Another result of the pushing inwards of the spout 62 is that the portion 17 of the panel 52 bounded by the groove 16'' is pressed inwards, so breaking the gaseous substance barrier layer 14 and the inner thermoplastics layer 15 at the limited zones 14A'' and 15''A, so that the portion 17 hinges about the bridging portion 77 between the portion 17 and the remainder of the

panel 52.

The fitment 43 and the portion 17 are now in a condition ready for pouring, whereupon the carton 51 is tilted in the sense of the arrow A in Figure 9. Owing to the location of the opened portion 17 at the upper rather than the lower side of the spout 62, the liquid 55 being poured tends, if anything, to push the portion 17 further away from the entry to the spout 62, rather than pushing it towards that entry.

When it is desired to reclose the pouring fitment 43 for further pouring later, the cap 67 is screwed back onto the ring 69 and its skirt 70 fits sealingly in the surface 65.

The forming of the holes, such as the grooves 16, 16', and 16'', and the heating of the limited zones, such as 15A, 15A', and 15A'', do not have to be performed at the particular system stages described with reference to the drawings, but can be performed at differing stages in the systems.

It will be understood that the particular varieties of system described above with reference to the drawings are not limited to production of the particular containers illustrated for the respective varieties, but each can be used to produce containers of a different character.

Also, it will be appreciated that the present invention is applicable to a wide variety of systems for producing filled and sealed containers.

CLAIMS

1. A method comprising providing a laminate (11) comprised of a polymer layer (15; 14,15) and a covering (12,13) extending over a surface of said polymer layer (15; 14,15), with the external surface of the covering (12,13) being provided with a hole (16; 16'; 16'') therethrough, characterized by transmitting energy by way of said hole (16; 16'; 16'') to a limited zone (15A; 14A, 15A; 15A'; 14A'',15A'') of said polymer layer (15; 14,15) substantially aligned with said hole (16; 16'; 16'') to heat said limited zone (15A; 14A, 15A;15A'; 14A'', 15A'') to a temperature such that, following cooling of the limited zone (15A;14A,15A; 15A'; 14A'', 15A''), said limited zone (15A;14A,15A;15A'; 14A'',15A'') is more readily breakable.

2. A method according to claim 1, wherein said heating is selected from the group consisting of heating by hot air, radiant heating, ultrasonic heating and inductive heating.

3. A method according to claim 1 or 2, wherein said heating and said cooling do not substantially alter the shape of said limited zone (15A; 14A,15A;15A'; 14A'', 15A'').

4. A method according to any preceding claim, wherein said covering (12,13) includes an oxygen barrier layer (14) and said hole (16,16'; 16'') extends from said external surface of said covering (12,13) to substantially the surface of said barrier layer (14) nearer said covering (12,13).

5. A method according to claim 4, wherein said barrier layer (14) comprises a metal foil by which the energy supplied by way of said hole (16') is conducted to said limited zone (15A').

6. A method according to any one of claims 1 to 3, wherein said polymer layer (15) comprises an oxygen barrier layer.

7. A method according to any preceding claim, wherein the time period of said heating, at at ~~lea~~st the softening point of said polymer layer (15;14, 15), is between 0.1s. and 5s.

8. A method according to claim 7, wherein said time period is between 0.5s. and 2.s.

9. A method according to any preceding claim and performed in a packaging machine (1) in which said laminate (11), starting in the form of a web (11), is converted into

packaging containers (8) substantially simultaneously with filling of product therein.

10. A method according to any one of claims 1 to 8, and performed in a packaging machine (35) to which said laminate (11) is supplied in the form of a packaging container blank (23) and in which said blank (23) is formed into an open container which is then filled and closed.

11. A method according to any one of claims 1 to 8 and performed in a converter (20) in which said laminate (11), starting in the form of a web (11), is converted into packaging container blanks.

12. A method according to any one of claims 9 to 11, wherein, after said cooling and after production of a filled and closed packaging container (8), another zone (17) of said polymer layer (15) around which said limited zone (15A; 15A'') extends is displaced to provide an aperture.

13. A method according to any one of claims 9 to 11, wherein, after said cooling and after production of a filled and closed packaging container (34), said packaging container (34) is torn open along said limited zone (15A').

14. A method according to any preceding claim, wherein said hole (16;16'; 16'') has been provided through said external surface by removing material of said covering (12,13).

15. Apparatus comprising supplying means for providing a laminate (11) comprised of a polymer layer (15; 14,15) and a covering (12,13) extending over a surface of said polymer layer (15; 14,15), with the external surface of the covering (12,13) being provided with a hole (16,16'; 16'') therethrough, characterized by energy-transmitting means (4;19;38) arranged to transmit energy by way of said hole (16,16'; 16'') to a limited zone (15A; 14A,15A; 15A'; 14A'', 15A'') of said polymer layer (15;14,15) substantially aligned with said hole (16,16'; 16'') to heat said limited zone (15A; 14A,15A; 15A'; 14A'', 15A'') to a temperature such that, following cooling of said limited zone (15A; 14A,15A; 15A'; 14A'',15A''), said limited zone (15A; 14A,15A; 15A'; 14A'',15A'') is more readily breakable.

16. Apparatus according to claim 15, wherein said energy-transmitting means (4;19;38) is selected from the group

consisting of hot air emitting means, radiant heating means; ultrasonic heating means and inductive heating means.

17. Apparatus according to claim 15 or 16, and further comprising hole-forming means (3;22;38) for forming said hole (16,16';16'') through said covering (12,13) by removing material of said covering (12,13).

18. Apparatus according to any one of claims 15 to 17, and in the form of a packaging machine (1) further comprising means (4,6,7) for converting said laminate (11), starting in the form of a web (11), into packaging containers (8) and filling means (5) for filling the same substantially simultaneously with said converting.

19. Apparatus according to any one of claims 15 to 17, and in the form of a packaging machine (35) further comprising means (36,37,38) for converting said laminate (11), starting in the form of a packaging container blank, into an open packaging container, filling means (40) for filling said container, and closing means (41) for closing said container.

20. Apparatus according to any one of claims 15 to 17, and in the form of a converter (20) in which said laminate (11), starting in the form of a web (11), is converted into packaging container blanks (23).

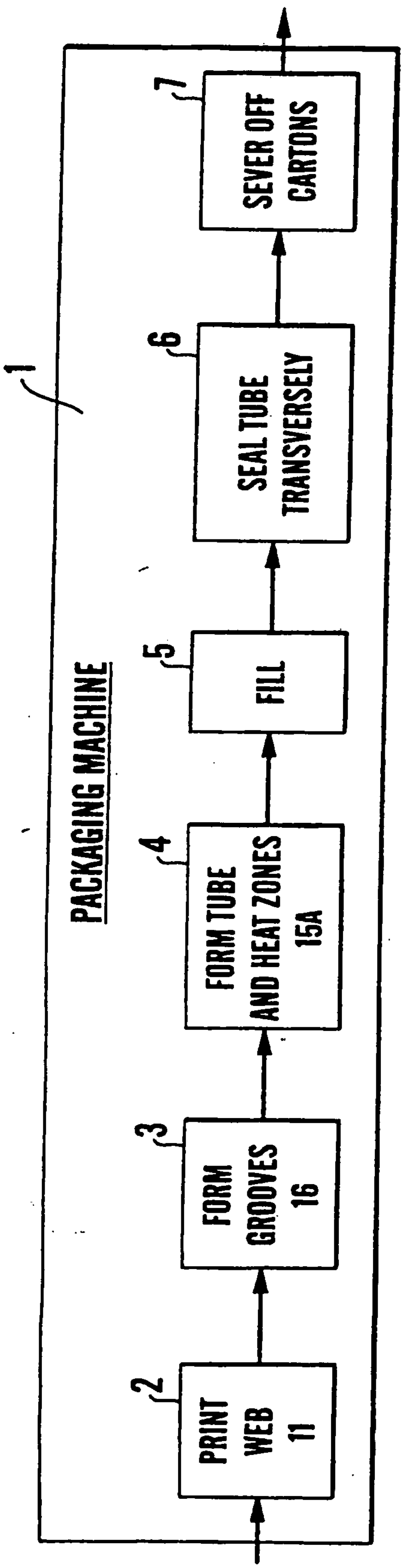

PACKAGING MACHINE
1
2
PRINT WEB 11
3
FORM GROOVES 16
4
FORM TUBE AND HEAT ZONES 15A
5
FILL
6
SEAL TUBE TRANSVERSELY
7
SEVER OFF CARTONS

Fig. 1

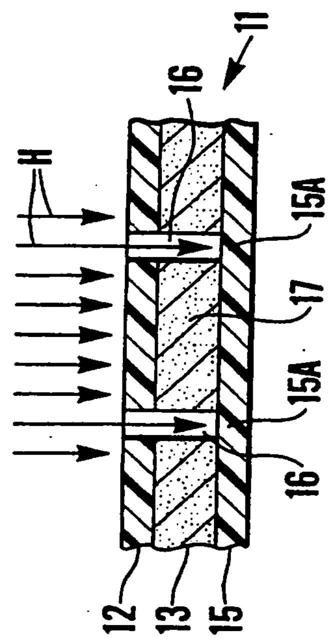

11
16
H
15A
17
15A
16
12
13
15

Fig.2

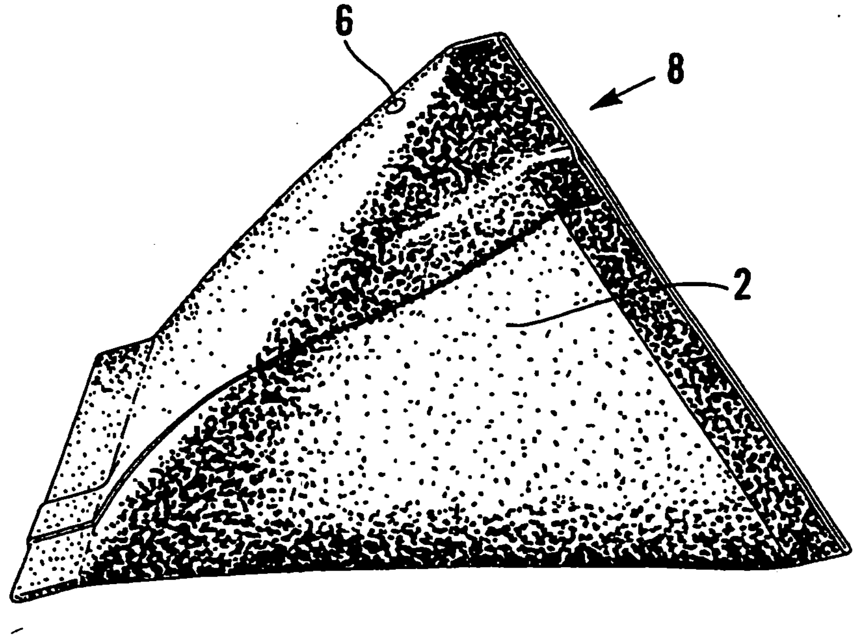


Fig.3

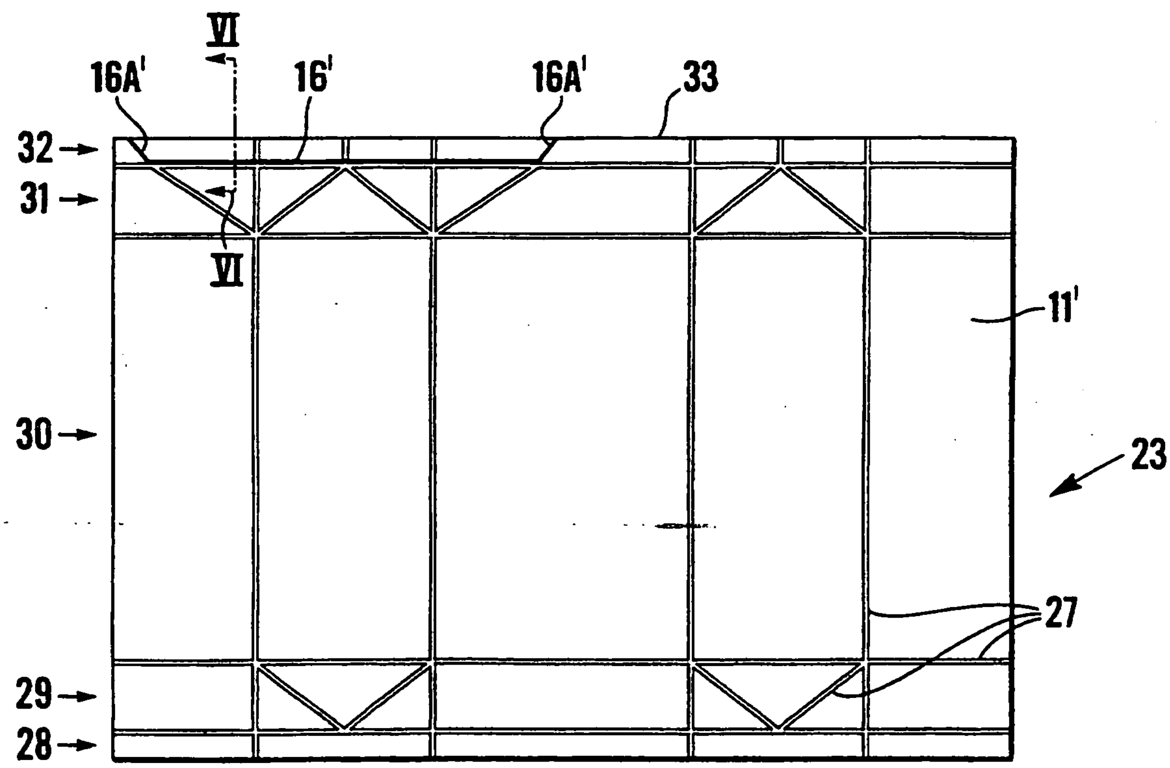


Fig.5

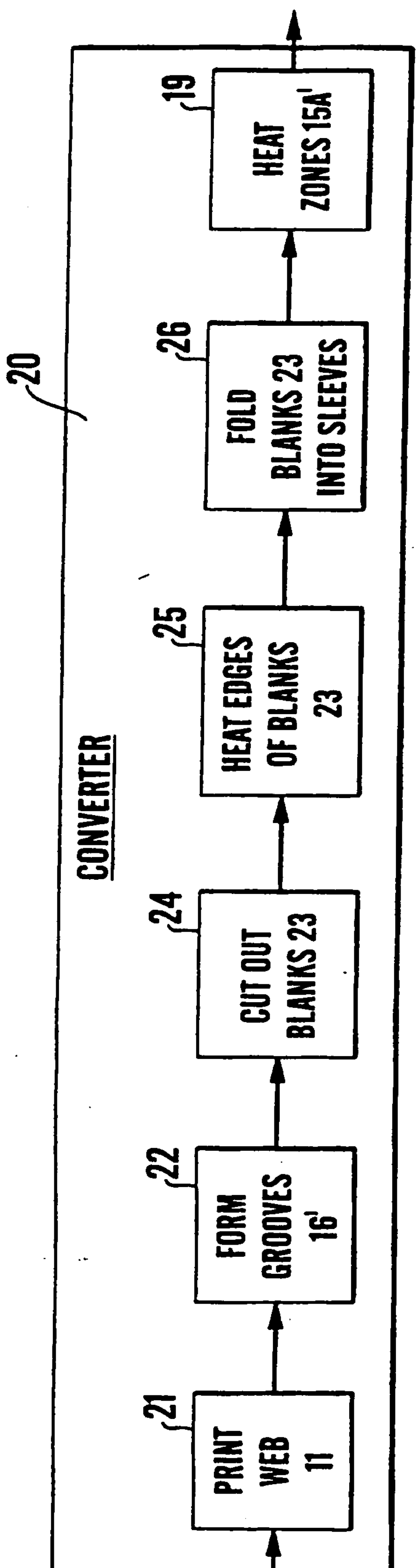

20
CONVERTER
21
PRINT WEB 11
22
FORM GROOVES 16'
24
CUT OUT BLANKS 23
25
HEAT EDGES OF BLANKS 23
26
FOLD BLANKS 23 INTO SLEEVES
19
HEAT ZONES 15A'

Fig.4

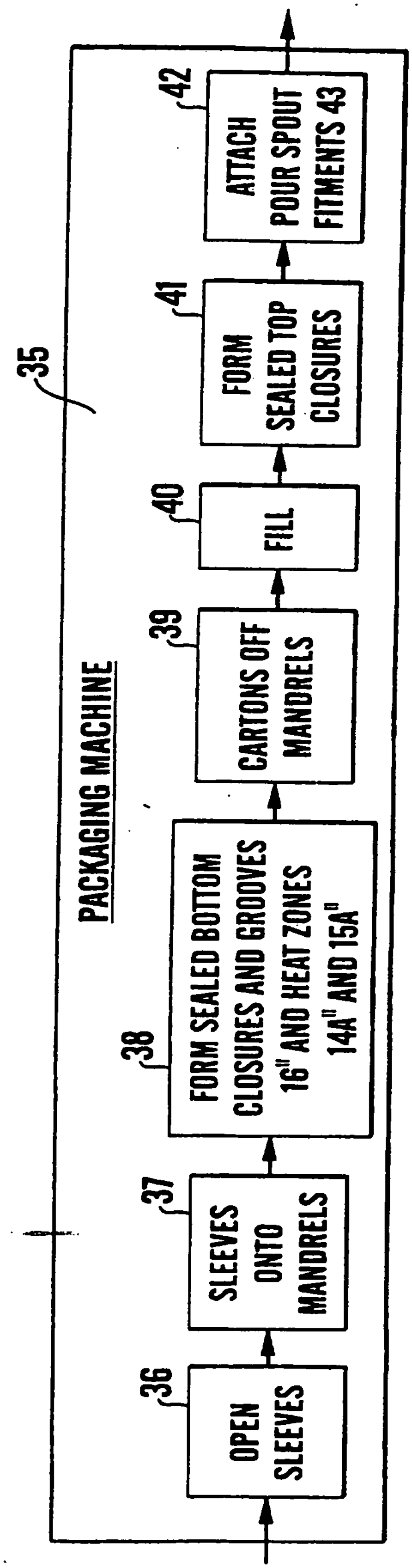

35
PACKAGING MACHINE
36
OPEN SLEEVES
37
SLEEVES ONTO MANDRELS
38
FORM SEALED BOTTOM CLOSURES AND GROOVES 16'' AND HEAT ZONES 14A'' AND 15A''
39
CARTONS OFF MANDRELS
40
FILL
41
FORM SEALED TOP CLOSURES
42
ATTACH POUR SPOUT FITMENTS 43

Fig.8

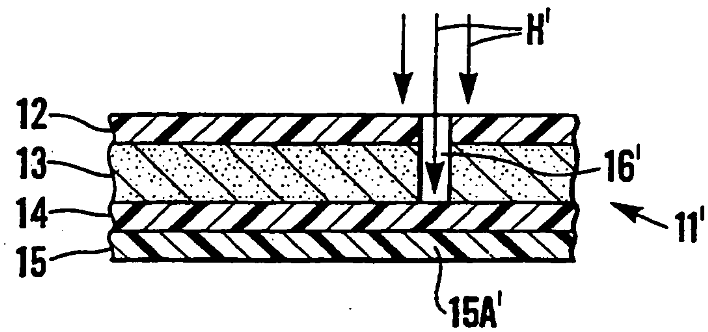


Fig.6

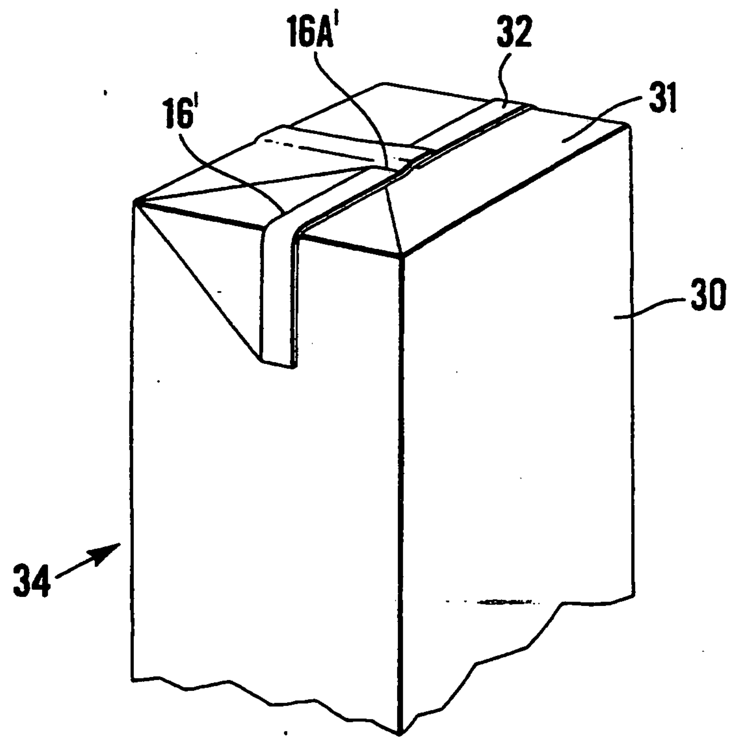


Fig.7

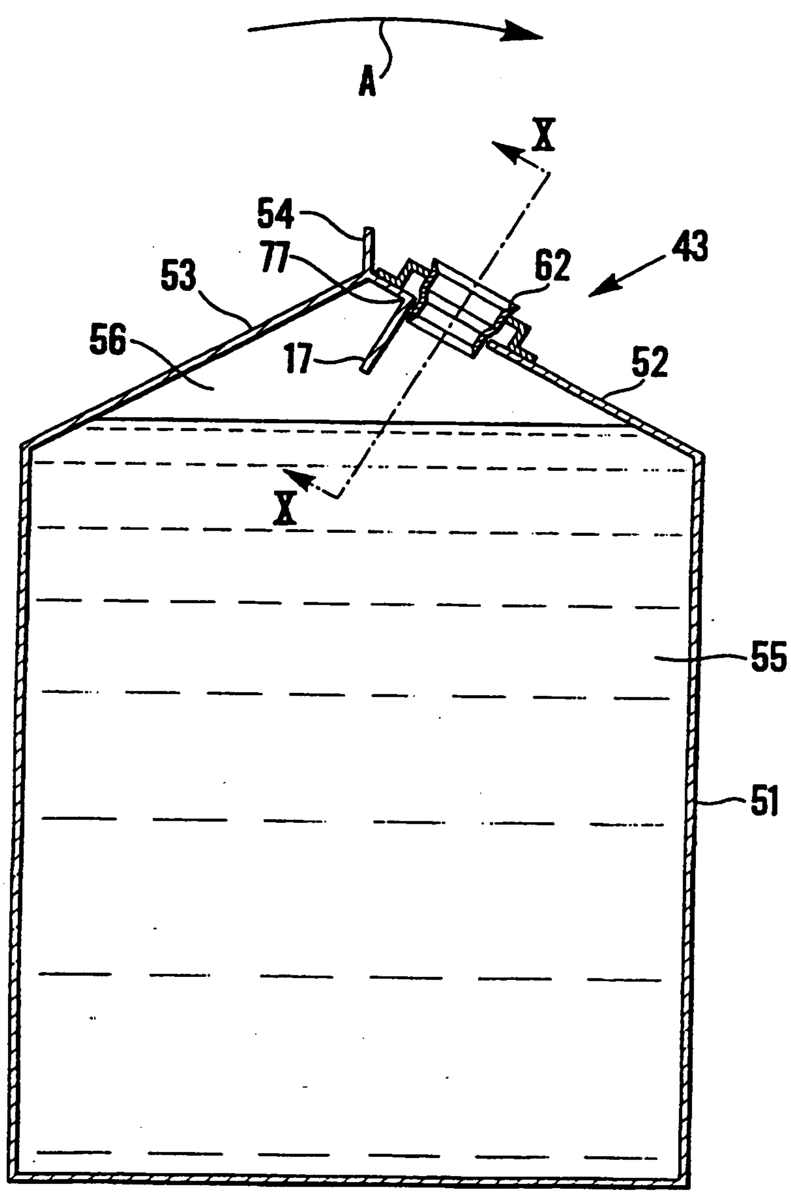


Fig.9

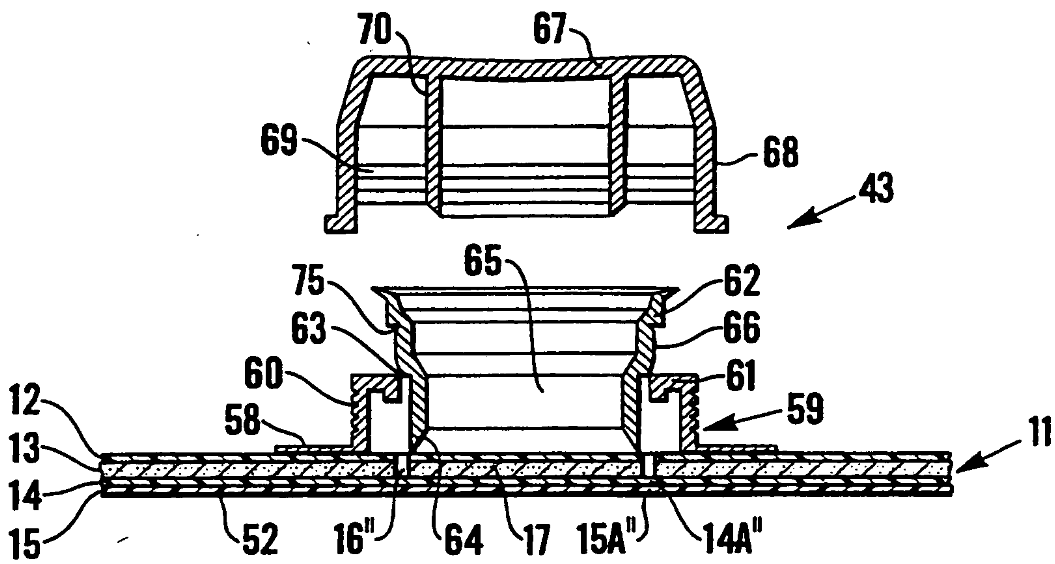

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Fig. 10

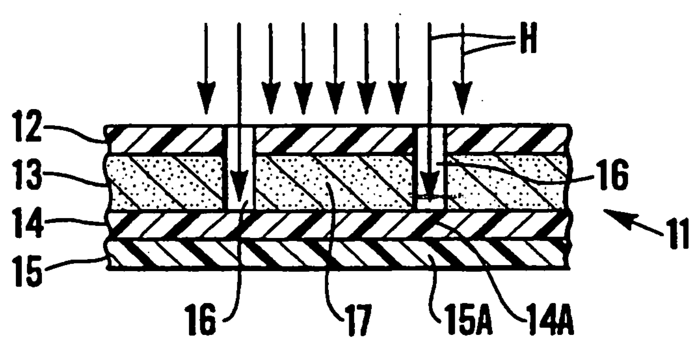
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Fig. 11